LOS ALTOS SEISMIC SAFETY ELEMENT

October 12, 1976

Earth Sciences Associates

[Los Altos. City council]
City planning Los Altos
Emerg. relief Earthquakes " "

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I. INTRODUCTION

The primary objective of this Seismic Safety Element is to recommend policies and actions to the City Council which will minimize the number of deaths and injuries, minimize property damage, and help minimize the social and economic disruption within the Los Altos Planning Area that could result from a major earthquake. A comprehensive plan must designate (1) actions to be taken in advance of the earthquake, including scientific evaluation of lands, adoption of design standards for new structures and for the modification of certain existing ones, and the institution of educational programs, and (2) plans to be put into effect after the earthquake to cope with the disaster and to help restore as rapidly as possible the life of the community.

Decisionmakers in other parts of the country, acting with the help of federal agencies, have developed sophisticated warning and response systems to deal with disasters resulting from floods, hurricanes, and tornadoes. In California it is only comparatively recently that the same kinds of research and planning have been undertaken to prepare for the equally devastating effects of earthquakes.

Those who attempt to plan for a seismic disaster soon discover that the long periods of time that usually intervene between major earthquakes have instilled a dangerous complacency in people and that reference to historical accounts has provided them with misleading information. One need only think of the changes in population density and lifestyle that have taken place in the last seventy years to realize that the effects on the Los Altos Area of the 1906 San Francisco Earthquake would be very different if it were to occur today. The great interdependency of our contemporary urban society with regard to modes of transportation; sources of power, food, and water; waste disposal; police and fire protection stands in sharp contrast to the rural self-sufficiency of Los Altos' "horse and buggy" days. Furthermore, the 1908 Carnegie Report, our principal source of information about earthquake effects in our area, deals almost exclusively with the structural rather than with the human and social impact of the disaster.

A description of what one could expect in the Planning Area from an earthquake of the same intensity as that which occurred in 1906, adapted from the Modified Mercalli Scale, includes the following observations:

> There is general fright or panic; chimneys and columns break and fall; wood frame houses are thrown off their foundations; some buildings collapse; windows shatter; furniture overturns; walls and cornices fall; concrete irrigation ditches are considerably damaged; there are changes of water flow in wells; reservoirs are damaged; underground pipes rupture; trees and power poles fall.

And there is no assurance that even more devastating effects might not result! In addition, the number of deaths and injuries and the degree of social disruption would depend heavily on whether the

earthquake occurred during daytime or nighttime, whether during commute or school hours, whether during the dry or rainy season, etc. Furthermore, it must be anticipated that emergency efforts will be hampered by shortages, or indeed, even a total lack of gas, electricity, telephone, water, and sewer services from conventional sources.

Though aware of the possible cataclysmic results of a major earthquake, decisionmakers must not give in to pessimism and fail to prepare as thoroughly as possible for an impending disaster. It is clear that there are a great many actions that the City could take that would eliminate or reduce earthquake hazards. In choosing among them some standard needs to be applied. One approach to determining the limits of local government's responsibility (suggested by the State of California Council on Intergovernmental Relations) employs the concept of "acceptable risk". It recognizes that hazards are an unavoidable aspect of life and that we come to view a certain degree of risk associated with a hazard as acceptable when it is both (1) no greater than that tolerated in everyday situations, and (2) when the means of eliminating or significantly reducing the risk is impractical or the costs involved are out of proportion to the benefits obtained.

At the same time as there are limits to the situations with which the City reasonably can be expected to concern itself, there are also situations where no amount of planning could guarantee adequate official response to the destruction, confusion, and community paralysis that could prevail. In such an emergency the combined responsible actions of individual citizens will have a great deal to do with how Los Altos comes through the disaster. This fact underlines the strong need for a continuing City-wide educational program as an integral part of the City's earthquake preparedness plan.

There follow in this report sections that define earthquake hazards, describe the geologic and seismic environment of the Planning Area, outline the earthquake history of the region, indicate the frequency with which Los Altos may expect damaging earthquakes in the future, and suggest the damaging effects of major earthquakes within the City. These sections lead to the recommended policies and actions. At this point it is important, however, to emphasize that the Seismic Safety Element cannot be considered in isolation but must be seen in relation to the other elements of the General Plan. A summary of relationships includes:

Elements	Relationship to Seismic Safety
Open Space/ Conservation	1. Designation of Hazard Zones as open space
Community Facilities	1. Designation of and provision for adequate evacuation and first aid centers
Housing	1. Identification of areas where no housing should be built

	2.	Designation of official steps in design approval to avoid hazards in residential construction
Land Use	1.	Identification of hazardous geologic features or zones where development should be limited or special studies required
	2.	Identification of existing hazardous land uses
Circulation and Scenic Highways	1.	Identification of routes within the City and nearby which are likely to be impassable following a major quake
	2.	Identification of alternate routes for evacuation, medical services, and inbound supplies
Safety	1.	Formation of Seismic Safety Committee
	2.	Designation of City personnel to activate or enforce adopted recommendations
	3.	Designation of cooperative actions with utility companies and other jurisdictions to provide emergency power and communication equipment
	4.	Preparedness planning in cooperation with State or County earthquake agencies and under the direction of the Seismic Safety Committee

II. DEFINITION OF GEOLOGIC HAZARDS

A. Ground Shaking

Most of the damage caused by earthquakes results from movement and shaking of the ground as earthquake waves pass through it. Since the nature of the ground motion is strongly influenced by the type and thickness of the underlying rock or soil, identical buildings located on different earth materials may experience different degrees of damage from the same sized earthquake. The extent of damage is also strongly dependent on the type of construction and the quality of workmanship and materials.

Poorly constructed or unreinforced masonry buildings will usually be damaged more than wood frame structures in the same area. While improved structural designs developed by earthquake engineers have increased the safety of modern buildings, even better building criteria will be developed as seismic data continues to be collected and evaluated.

B. Fault Ground Rupture

Faults are fractures or fracture zones in the earth's crust along which there has been displacement of the two sides relative to one another. Earthquakes are a result of sudden displacement along faults. Such displacement may be a few inches to several feet. Cumulative displacement through geologic time along large fault systems may reach hundreds of miles.

The zone of actual rupture along a fault is small compared to the area which is subjected to severe ground shaking. However, structures resting directly on or along such fault zones could be subjected to severe damage should displacement take place. Observation shows that faults are more likely to rupture along the traces of most recent breaks. It is not economically feasible to build structures which would withstand the shearing stresses which accompany such fault movement.

These facts have been recognized in the State of California by the enactment of the Alquist-Priolo Geologic Hazards Zones Act (Chapter 7.5, Division 2 of the California Public Resources Code), which establishes special study zones centered on active faults. The purpose of the Act is to provide for public protection from the hazard of fault rupture by avoiding, to the extent possible, the construction of structures for human occupancy across active fault traces. The State Division of Mines and Geology has delineated special study zones so that active fault traces may be avoided during development along potentially active faults. Although, at present, none of these study zones extend into the Los Altos Planning Area, there are known fault traces as indicated later in this element.

C. Landsliding, Slumping, and Mudflows

These are on-going processes of downslope earth movement capable of being accelerated by earthquake shaking, particularly during the

rainy season when the ground may be water-saturated. Damage varies according to the type and degree of slope failure which occurs. When private homes are involved in landsliding, they are often a total loss to the owner. Small mudflows may do only minor structural damage, but because of their rapid movement, they are capable of trapping or burying people and of destroying landscaping, interiors, and automobiles. Large mudflows may cause significant structural damage as well. Blockage of water courses due to slope failures can cause flooding during months of high flow.

D. Soil Liquefaction

Soil liquefaction results from a loss of soil strength during earthquake shaking. The most susceptible soils are clean, uniformly graded, loose, water-saturated, fine-grained sands and silts. The liquefaction of soils can cause them to move laterally outward from under buildings, bridges or other structures. Damage is usually greatest to large or heavy structures on shallow foundations, and takes the form of cracking, tilting, and differential settlement. Where gentle slopes exist, such as on stream or slough banks, liquefaction may cause laterally spreading landslides. Whole buildings can be moved downslope by this type of ground failure. Where susceptible soils are known to exist, special structural and foundation design is required to help minimize the liquefaction hazard in new construction.

E. Settlement and Subsidence

Structures located on loosely compacted soils, such as bay muds, are often subject to sinking or tilting as consolidation occurs. Differential settlement can cause foundation cracking and other structural damage.

Subsidence is a regional lowering of ground surface often associated with gradual ground water or petroleum withdrawal over a period of many years. Elevation changes of several feet are not uncommon; over eight feet of subsidence has been recorded in parts of the Santa Clara Valley.

F. Lurching

Lurch cracking or lurching is a phenomenon that occurs during earthquake ground shaking and involves the horizontal movement of soil masses toward an open face such as along creek banks. Creekside homes are especially vulnerable to damage from lurch cracking.

G. Earthquake-induced Flooding

Flooding can occur as a result of earthquake damage to dams, canals, water towers, or pipelines and by sudden change of water table during earthquakes. Flood hazard may be severe or minor, depending on the potential inundation area and the volume of water involved.

rainy season when the ground may be water-saturated. Damage varies according to the type and degree of slope failure which occurs. Some failures damage are survived in satisfactory, they are often a total loss to the owner. Small mudflows may do only minor structural damage, but damage of thirty rapid water, or, they are capable of toppling or burying people and of destroying landscaping, landscape, and driveways. Large mudflows may cause extensive structural damage as well. Damage or water courses due to slope failures can cause flooding in the zones of high flow.

b. Soil Liquefaction

Soil liquefaction results from a loss of soil strength during earthquake shaking. The most susceptible soils are clean, uniform grades, loose, water-saturated, fine-grained sands and silts. The liquefaction of soils can cause them to move laterally outward from under buildings, bridges or other structures. Damage is usually proportional to large or heavy structures on shallow foundations, and takes the form of sagging, tilting, and differential settlements. Large sandy slopes exist, much or on either or along banks, liquefaction may cause laterally spreading landslides. Where buildings can be moved downslope by only, even of ground failure. Where desirable soils are known to exist, special preconstruction and foundation design is required to help minimize the liquefaction hazard in new construction.

c. Subsidence and Subsidence

Subsidence occurs on loosely compacted soils, such as bay muds, are often subject to shrinking or settling as consolidation occurs. Differential settlement can cause foundation cracking and other structural damage.

Subsidence is a regional lowering of ground surface often associated with gradual ground water or petroleum withdrawal over a period of many years. Elevation changes of several feet are not uncommon over large feet of subsidence has been recorded in parts of the Santa Clara Valley.

d. Landslides

Rock slumping or landslides is a phenomenon that occurs during earthquake shaking and involves the horizontal movement of soil masses toward an open face such as along rock banks. Landslide areas are regularly subjected to damage from heavy rainfall.

e. Inundation Flooding

Inundation can occur as a result of dam failure, damage to dams, water tanks, or pipelines and by sudden change of water levels during earthquakes. Flood hazard may be present on slopes, depending on the potential inundation area and the nature of the hazard.

H. Tsunamis and Seiches

Tsunamis are large ocean waves caused by vertical faulting of the ocean floor. Such earthquake-associated waves can cause considerable damage when they impinge on coastlines. Because of its elevation, Los Altos does not include any areas which are subject to tsunami inundation.

Seiches are waves produced in reservoirs, lakes, and other closed or restricted bodies of water by ground shaking. The phenomenon is similar to the oscillations that result when a bowl of water is shaken. Such waves can cause overtopping of dams and, therefore, pose a threat to urbanized areas below.

III. GEOLOGIC AND SEISMIC ENVIRONMENT

A. Description of Rock Units

1. General

The City of Los Altos is underlain by a series of geologic units which are described below. The upper three units vary in thickness to over 1,000 feet. These deposits have been laid down over the last three million years by streams carrying sediments out of the Santa Cruz Mountains toward San Francisco Bay. Three alluvial units are recognized within the City: (1) The Santa Clara Formation; (2) The Older Alluvial Fan Deposit; and (3) The Younger Alluvial Fan Deposit. Beneath these alluvial deposits is the older Monterey Shale.

2. Monterey Shale

This rock unit of Miocene age (15 million years) varies in thickness from 500 to 1,500 feet. In the vicinity of Los Altos, where it is exposed at the surface, it is generally a highly fractured, semi-siliceous, marine shale, pale orange or white where weathered, and grayish-brown or brownish-black where fresh. Exposures in the Planning Area are limited to several small areas along Interstate Highway 280.

3. Santa Clara Formation

This alluvial unit is of Plio-Pleistocene age (1-2 million years) and is exposed as reddish-brown, moderately well consolidated, non-marine sands and gravels in the southern part of the City between Foothill Expressway and Junipero Serra Freeway (Interstate 280). Sand and gravel are present as irregular, lenticular beds, within a conglomerate composed of hard, subrounded cobbles and pebbles in a sandy silty matrix. The unit extends to a depth of at least several hundred feet. In the northern part of the City it is covered by the Older Alluvial Fan unit. Soils developed on the Santa Clara Formation often contain expansive clays which cause them to crack when dry and swell when wet. Although not a seismic hazard in themselves, expansive clay soils can weaken structures built on them. They can cause cracking and heaving of concrete slabs, patios, roads, sidewalks, and swimming pools. Differential movement beneath structures may result in cracked walls, ceilings, and windows. Proper foundation design can reduce or eliminate the potential for damage if expansive soils are identified before construction.

4. Older Alluvial Fan Deposits

This is the unit upon which most of the City is built. It is composed of reddish-brown, unconsolidated, non-marine sands and gravels which were deposited on top of the Santa Clara Formation during late Pleistocene time. These older fan deposits commonly display a well developed soil profile and locally may have a hardpan layer several feet below the surface which effectively impedes the flow of water. The older alluvial fan unit thickens to the east to a thickness of 700 feet (Pampeyan, 1970). Soils formed on this unit are often expansive.

5. Younger Alluvial Fan Deposits

Overlying the Older Alluvial Fan Deposit in some areas is a layer less than 20 feet thick of unconsolidated fine-grained sand and silt with some gravel lenses known as the Younger Alluvial Fan Unit. This unit, of Holocene age (10,000 years) represents current alluvial fan development along contemporary drainages such as Stevens Creek. Since the Younger Alluvial Fan deposits are less than 10,000 years old, they do not have well developed soil horizons. This unit is found only in the easternmost part of Los Altos, north of Foothill Expressway.

B. Topography

Although most of the Planning Area is located on a gently sloping alluvial plain, slopes south of Foothill Expressway are commonly between 5-30%, and sometimes as much as 50%. Steep slopes combined with unstable geologic conditions can cause landsliding or slumping, particularly when grading operations disturb natural conditions. Strong earthquake shaking can trigger landslides in these rocks where bedding is oriented in a downslope direction or has been exposed in a cut.

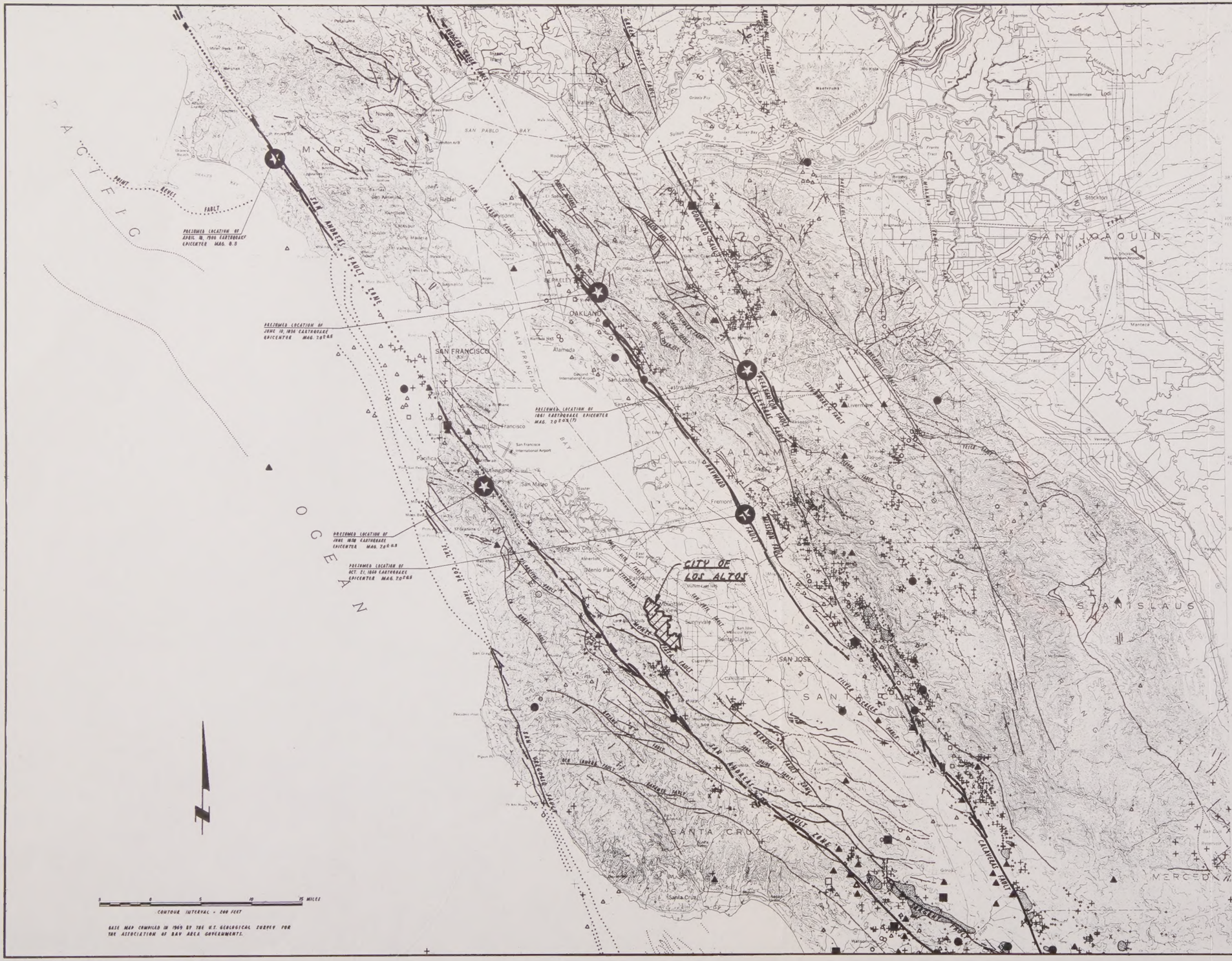
The Santa Clara Formation is of such variable lithology that it is difficult to generalize about its stability. However, Rodgers and Armstrong (1973) have assigned it a very low stability rating. If detailed City and County landslide records were available for past slope failures, a realistic assessment of slope instability conditions within the Planning Area might be possible. At the present time, information is not sufficient to make a stability map of the Los Altos Foothills area, and the City must depend on site investigations by engineering geologists to assess landslide hazards.

C. Important Faults and Regional Seismicity

The most obvious criterion for recognizing an active fault is documented movement along it associated with historical earthquakes. Other criteria which may occur alone or in combination are:

1. Displacement of Holocene deposits (soil or rock less than 10,000 years old).
2. Evidence of fault creep (slow ground displacement without earthquakes).
3. Seismic activity along the fault plane.
4. Displaced survey lines (such as Coast and Geodetic Survey triangulations).
5. Geomorphic evidence (such as offset stream courses, sag ponds, scraps, fault troughs, and fault saddles).

Although there are no known active faults within the Los Altos Planning Area, it does not mean that some may not exist. The San Francisco Bay region is an area of high seismicity, and there are several active faults known which are not far from the City. Table 1 lists the known active faults within 100 kilometers of Los Altos



EXPLANATION

HAYWARD FAULT — FAULT ON WHICH SURFACE MOVEMENT HAS OCCURRED DURING HISTORIC TIME.

GREEN VALLEY FAULT — FAULT WITHOUT KNOWN HISTORIC MOVEMENT, BUT WHICH DISPLACES QUATERNARY DEPOSITS

FAULT ON WHICH NO EVIDENCE OF RECENT MOVEMENT IS REPORTED.

ALL FAULTS DASHED WHERE APPROXIMATELY LOCATED, AND DOTTED WHERE CONCEALED BENEATH WATER OR SURFICIAL MATERIALS.

SOURCES FOR FAULT AND EARTHQUAKE MAP

FAULTS AND EARTHQUAKE EPICENTERS SHOWN ON MAP WERE COMPILED FROM THE FOLLOWING SOURCES:

I. FAULTS

a. BROWN JR, R.D., 1970. FAULTS THAT ARE HISTORICALLY ACTIVE OR THAT SHOW EVIDENCE OF GEOLOGICALLY YOUNG SURFACE DISPLACEMENT, SAN FRANCISCO BAY REGION: US GEOLOGICAL SURVEY OPEN FILE MAP.

b. CALIFORNIA DEPARTMENT OF WATER RESOURCES, 1967. EVALUATION OF GROUND WATER RESOURCES. SOUTH BAY, APPENDIX A: GEOLOGY: DWR BULL. NO. 118-1.

c. CALIFORNIA DIVISION OF MINES AND GEOLOGY, GEOLOGIC MAP OF CALIFORNIA: SACRAMENTO, SAN FRANCISCO, SAN JOSE, AND SANTA ROSA SHEETS.

d. CALIFORNIA DIVISION OF MINES AND GEOLOGY, 1973. PRELIMINARY FAULT AND GEOLOGIC MAP OF CALIFORNIA: CSMG. PRELIMINARY REPORT 13.

e. EARTH SCIENCES ASSOCIATES, 1969-1975; DATA FROM VARIOUS UNPUBLISHED MAPS.

f. GRIGNE, R.G. AND OTHERS, 1973. FAULTS AND EARTHQUAKES IN THE MONTEREY BAY REGION, CALIFORNIA: US GEOLOGICAL SURVEY MISC. FIELD STUDIES MAP MF-518.

g. HAUL, R.R., 1967. THE CALAVERAS FAULT ZONE IN CONTRA COSTA COUNTY: MINERAL INFORMATION SERVICE V. 20, NO.3.

h. JONES, D.K. AND R.J. McCAUGHLIN, 1975. GEOLOGIC MAP OF THE SARGENT-BERROCA FAULT ZONE BETWEEN LOS GATOS AND LOS ALTOS HILLS, SANTA CLARA COUNTY, CALIFORNIA: US GEOLOGICAL SURVEY MISC. FIELD STUDIES MAP MF-693.

j. WESSON, R.L., AND OTHERS, 1975. FAULTS AND FUTURE EARTHQUAKES IN STUDIES FOR SEISMIC ZONATION OF THE SAN FRANCISCO BAY REGION: US GEOLOGICAL SURVEY PROFESSIONAL PAPER 941-A, PP. A5-A80

II. EARTHQUAKE EPICENTERS

a. CALIFORNIA DEPARTMENT OF WATER RESOURCES, 1964. CRUSTAL STRAIN AND FAULT MOVEMENT INVESTIGATION. DWR BULL. NO. 116-2.

b. BOLT, B.A., CINDA LOMNITZ, AND T.V. McEVILLY, 1968. SEISMOLOGICAL EVIDENCE ON THE TECTONICS OF CENTRAL AND NORTHERN CALIFORNIA AND THE MENDOCINO ESCARPMENT. BULL. SEISMOL. SOC. AMER., VOL. 58, NO.6, PP. 1725-1767.

c. BOLT, B.A., AND R.D. MILLER, 1971. SEISMICITY OF NORTHERN AND CENTRAL CALIFORNIA, 1963-1969; BULL. SEISMOL. SOC. AMER., VOL. 61, NO.6, PP. 1831-1847.

d. CALIFORNIA DIVISION OF MINES AND GEOLOGY, 1972. PRELIMINARY EARTHQUAKE EPICENTERS MAP OF CALIFORNIA, 1934-1971 (JUNE 30): CALIF. DIV. MINES AND GEOL., SEISMIC SAFETY INFORMATION, ITEM 72-9

e. US GEOLOGICAL SURVEY, 1972. SEISMICITY MAP OF GREATER SAN FRANCISCO BAY AREA, CALIFORNIA, 1969-1971: USGS OPEN FILE MAP.

EXPLANATION FOR EARTHQUAKE EPICENTER DATA

EARTHQUAKE EPICENTERS, MAGNITUDE 2.5-6.0, 1934 THROUGH 1961 FROM DATA SOURCE 2a, CALIF. DWR BULL. NO 116-2; 1962 THROUGH 1968 FROM DATA SOURCE 2b, BOLT AND McEVILLY, 1968; 1969 THROUGH 1969 FROM DATA SOURCES 2c, BOLT AND MILLER, 1971; AND 2d, CSMG 1972.

SYMBOL	MAGNITUDE
△	2.5 - 3.0
○	3.1 - 3.5
□	3.6 - 4.0
▲	4.1 - 4.5
●	4.6 - 5.0
■	5.1 - 5.5
⬢	5.6 - 6.0
★ MAGNITUDE AND DATE NOTED	6.0 - 8.5

EARTHQUAKE EPICENTERS, MAGNITUDE 0.5 TO 3.5, 1969 THROUGH 1971, FROM DATA SOURCE 2e

SYMBOL	MAGNITUDE
NUMEROUS EPICENTERS OF 0.5 - 2.5 RANGE	
·	0.5 - 1.5
+	1.5 - 2.5
X	2.5 - 3.5
X	> 3.5

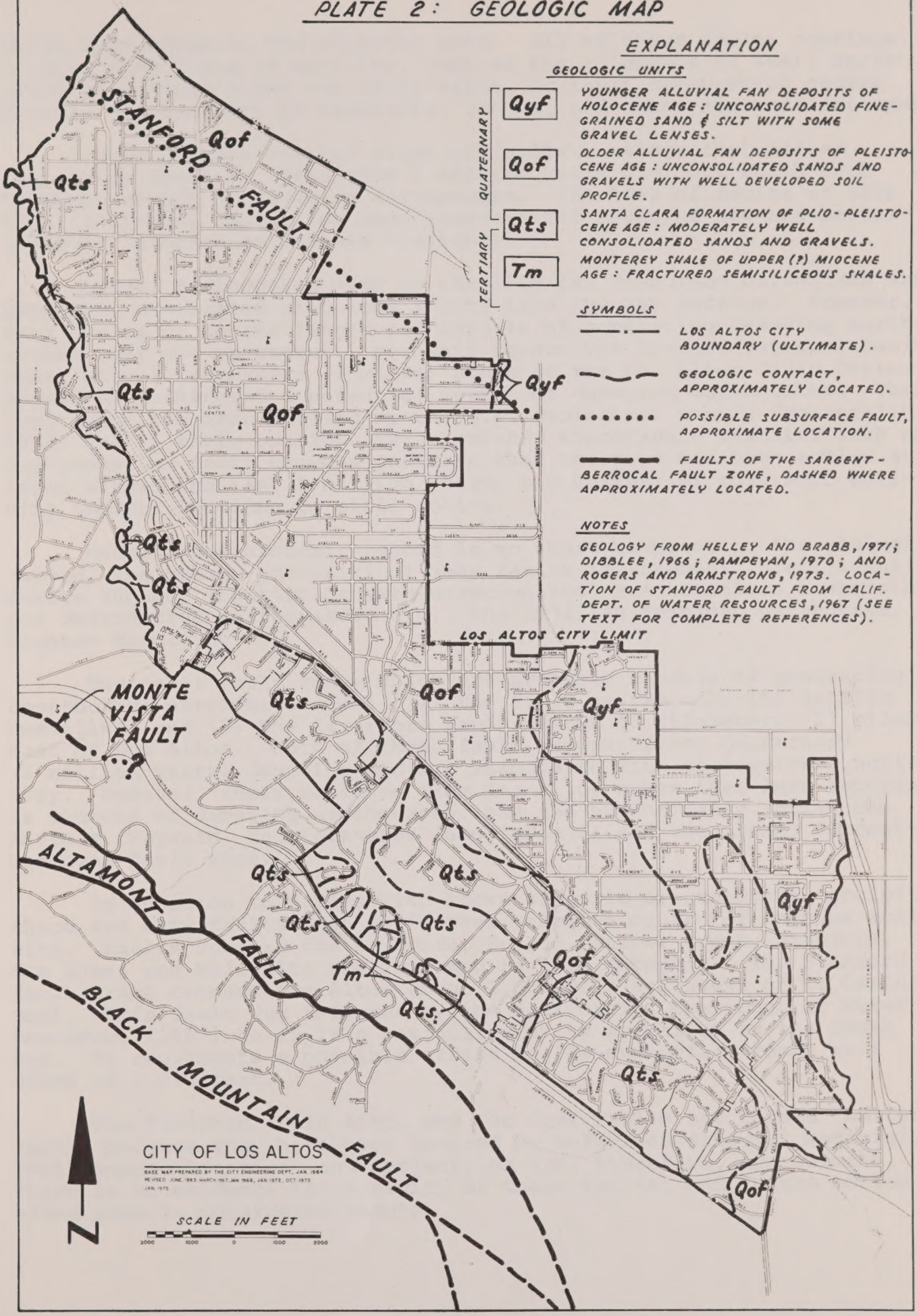
Earth Sciences Associates
Palo Alto, California

CITY OF LOS ALTOS
SEISMIC SAFETY ELEMENT

SEISMICITY OF THE
SAN FRANCISCO BAY REGION

Checked by S. Thum	Date 3/76	Project No.	Figure No.
Approved by RCH	Date 3/76	1617	1

PLATE 2: GEOLOGIC MAP



which have moved in the historic past. All of these faults continue to show some signs of activity, such as the alignment of small earthquake epicenters along the fault trace, or fault creep which causes gradual displacement of sidewalks, fences, and other man-made features.

Table 2 lists another class of faults -- those that offset Quaternary deposits (less than 2 million years old) but which lack historic record of damaging earthquakes. The list of faults of this type is growing larger for many geographical areas as new and better geologic information becomes available.

Larger earthquakes such as the 1906 San Francisco earthquake are generally associated with long faults like the San Andreas. However, many faults of lesser length are capable of generating damaging earthquakes near the epicenter. For this reason the Sargent-Berrocal fault zone, only 3 kilometers (2 miles) south of the Los Altos Civic Center, should be considered a potential source of damaging earthquakes. This fault zone has been studied by the U.S. Geological Survey (McLaughlin 1975) and in their opinion, fault-related topographic features such as sag ponds and fault troughs indicate that the zone has been active at least within the last 1 million years, and current microseismic activity implies the zone is still active.

Because the historic record is so short compared to the geologic record, the damage potential of many faults is unknown. Significantly, faults thought inactive or even unrecognized, are sometimes responsible for destructive earthquakes, e.g., the 1971 San Fernando earthquake, Richter Magnitude 6.6.

Two other fault zones which are probably capable of generating destructive earthquakes are: (1) The fault system near the Pacific coastline; and (2) The Livermore fault system 43 kilometers (27 miles) east of Los Altos. Both of these fault groups offset Quaternary (2 million years) deposits and are associated with microseismic activity. However, their distance from Los Altos makes them less important as sources of damaging earthquakes than the historically active San Andreas, Hayward, and Calaveras (See Table 1) and the closer Sargent-Berrocal fault zone.

In addition to faults with known historic or Quaternary activity, there are many faults that are either inactive or are of unknown activity. Faults such as the La Honda, Butano, Silver Creek, Stanford, San Jose, and Palo Alto are included in this category. The Stanford fault trace crosses Los Altos about 2,000 feet southwest of El Camino Real. This fault was inferred by the California Department of Water Resources (1967) to explain residual gravity anomalies in the South Bay. It represents a possible offset in the subsurface rocks at a depth of 2,000 feet.

The Stanford, Palo Alto, and San Jose faults are termed "buried" faults because they have been covered by unfaulted alluvial material. Their mapped locations and projections are, therefore, approximate. There is no evidence for activity of these faults, and future motion along them is considered remote.

TABLE 1: FAULTS WITHIN 100km OF LOS ALTOS WHICH HAVE BEEN THE SOURCE OF DAMAGING HISTORIC EARTHQUAKES

Fault Name	Approx. Length	Approx. Distance from Los Altos Civic Center	Date and Magnitude (M)* Richter Scale Strongest Earthquake
San Andreas	966km (600 mi)	8km (5 mi)	1906: M = 8.3 (great San Francisco earthquake)
Calavaras/Pleasanton	116km (72 mi)	28km (17 mi)	1861: M* = 7
Hayward	74km (46 mi)	21km (13 mi)	1836: M* = 7
			1868: M* = 7
Concord	24km (15 mi)	61km (38 mi)	1955: M = 5

* Inferred from historical data

"Richter Magnitude (M) is a scientific measurement related to the total energy released by an earthquake and is not, therefore, dependent on an observer's distance from the epicenter or the local geologic conditions where the observer stands.

Modified Mercalli Intensity refers to a scale of observable earthquake effects and requires no measuring devices. For a given earthquake, Intensity depends on the Magnitude of the quake, one's distance from the epicenter, and the geologic conditions of one's location."

TABLE 2: FAULTS WITHIN 50km OF LOS ALTOS WHICH OFFSET QUATERNARY (LESS THAN 2 MILLION YEARS) DEPOSITS BUT WITHOUT DAMAGING HISTORIC EARTHQUAKE RECORD

Fault Name	Distance from City	Activity Criteria
Sargent/Berrocal fault zone	3km (2 mi)	Offset Holocene (10,000 years) deposits, microseismic events located along faults, especially near Sargent fault. Fault troughs and sag ponds.
Pilarcitos/Seal Cove/San Gregorio fault system	27km (17 mi)	Microseismic events, offset of Holocene deposits, geomorphic features.
Livermore Valley faults	43km (27 mi)	Creep, microseismic activity in area of faults, ground water anomalies.

D. Earthquake History

Earthquake records in California go back only about 200 years. Table 3 lists prominent historic earthquakes whose epicenters were within 100 kilometers (62 miles) of Los Altos. The best description of earthquake effects from a major quake in the Bay Area, and one which includes observations from Los Altos, is the 1908 Carnegie Commission Report of the 1906 San Francisco earthquake. Descriptions of the damage and effects permit the assignment of a Modified Mercalli Intensity Rating of approximately IX to the 1906 earthquake in the Los Altos area. When evaluating the pertinence of historical accounts, such as those contained in the Carnegie Report, one must remember that the area was sparsely settled, little developed, and cursorily examined in 1906. Building practices were different than those employed today: for example, brick buildings and chimneys were generally unreinforced. Comparisons between 1906 and the present must take into account the differences between today's highly interdependent urban society and the relatively self-sufficient rural population that existed in the area in 1906. A list of differences would include methods of transportation; sources of food, water and power; waste disposal; etc.

E. Future Earthquakes

Because scientific earthquake prediction is a relatively new endeavor, it is not possible at this time to predict the time, location or magnitude of a future earthquake. However, it is possible to forecast that earthquakes will continue to occur along the San Andreas, Hayward, Calaveras, and other active California faults and that Los Altos will be severely shaken by earthquakes in the future.

Measurements of the behavior of the earth's crust carried out by government and local university scientists indicate that earthquake forces are building up within the Bay Area. Therefore many geologists and seismologists believe that a large or great earthquake could occur at any moment. It is assumed a great quake would have characteristics similar to those of the 1906 quake.

Seismic activity between great earthquakes includes many smaller earthquakes, some of which may cause significant damage. Aftershocks, though not as large as the main earthquake, can cause damage to structures already weakened by preceding shocks. The historic record would lead one to anticipate damaging earthquakes in the Los Altos area several times per century. One might postulate as likely the following intensities and frequencies:

Intensity (Modified Mercalli)	Estimated Number of Occurrences during the next 50-100 years
IX (or possibly greater)	1
VIII	1-2
VII	2
VI	7

MODIFIED – MERCALLI INTENSITY SCALE OF 1931

I **Not felt by people, except under especially favorable circumstances. However, dizziness or nausea may be experienced.**

Sometimes birds and animals are uneasy or disturbed. Trees, structures, liquids, bodies of water may sway gently, and doors may swing very slowly.

II **Felt indoors by a few people, especially on upper floors of multi-story buildings, and by sensitive or nervous persons.**

As in Grade I, birds and animals are disturbed, and trees, structures, liquids and bodies of water may sway. Hanging objects swing, especially if they are delicately suspended.

III **Felt indoors by several people, usually as a rapid vibration that may not be recognized as an earthquake at first. Vibration is similar to that of a light, or lightly loaded trucks, or heavy trucks some distance away. Duration may be estimated in some cases.**

Movements may be appreciable on upper levels of tall structures. Standing motor cars may rock slightly.

IV **Felt indoors by many, outdoors by few. Awakens a few individuals, particularly light sleepers, but frightens no one except those apprehensive from previous experience. Vibration like that due to passing of heavy, or heavily loaded trucks. Sensation like a heavy body striking building, or the falling of heavy objects inside.**

Dishes, windows and doors rattle; glassware and crockery clink and clash. Walls and house frames creak, especially if intensity is in the upper range of this grade. Hanging objects often swing. Liquids in open vessels are disturbed slightly. Stationary automobiles rock noticeable.

V **Felt indoors by practically everyone, outdoors by most people. Direction can often be estimated by those outdoors. Awakens many, or most sleepers. Frightens a few people, with slight excitement; some persons run outdoors.**

Buildings tremble throughout, Dishes and glassware break to some extent. Windows crack in some cases, but not generally. Vases and small or unstable objects overturn in many instances, and a few fall. Hanging objects and doors swing generally or considerable. Pictures knock against walls, or swing out of place. Doors and shutters open or close abruptly. Pendulum clocks stop, or run fast or slow. Small objects move, and furnishings may shift to a slight extent. Small amounts of liquids spill from well-filled open containers. Trees and bushes shake slightly.

VI **Felt by everyone, indoors and outdoors. Awakens all sleepers. Frightens many people; general excitement, and some persons run outdoors.**

Persons move unsteadily. Trees and bushes shake slightly to moderately. Liquids are set in strong motion. Small bells in churches and schools ring. Poorly built buildings may be damaged. Plaster falls in small amounts. Other plaster cracks somewhat. Many dishes and glasses, and a few windows, break. Knick-knacks, books and pictures fall. Furniture overturns in many instances. Heavy furnishings move.

VII **Frightens everyone. General alarm, and everyone runs outdoors.**

People find it difficult to stand. Persons driving cars notice shaking. Trees and bushes shake moderately to strongly. Waves form on ponds, lakes and streams. Water is muddied. Gravel or sand stream banks cave in. Large church bells ring. Suspended objects quiver. Damage is negligible in buildings of good design and construction; slight to moderate in well-built ordinary buildings; considerable in poorly built or badly designed buildings adobe houses, old walls (especially where laid up without mortar), spires, etc. Plaster and some stucco fall. Many windows and some furniture break. Loosened brickwork and tiles shake down. Weak chimneys break at the roofline. Cornices fall from towers and high buildings. Bricks and stones are dislodged. Heavy furniture overturns. Concrete irrigation ditches are considerably damaged.

VIII **General fright, and alarm approaches panic.**

Persons driving cars are disturbed. Trees shake strongly, and branches and trunks break off (especially palm trees). Sand and mud erupts in small amounts. Flow or springs and wells is temporarily and sometimes permanently changed. Dry wells renew flow. Temperatures of spring and well waters varies. Damage slight in brick structures built especially to withstand earthquakes; considerable in ordinary substantial buildings, with some partial collapse; heavy in some wooden houses, with some tumbling down. Panel walls break away in frame structures. Decayed pilings break off. Walls fall. Solid stone walls crack and break seriously. Wet grounds and steep slopes crack to some extent. Chimneys, columns, monuments and factory stacks and towers twist and fall. Very heavy furniture moves conspicuously or overturns.

IX **Panic is general.**

Ground cracks conspicuously. Damage is considerable in masonry structures built especially to withstand earthquakes; great in other masonry buildings - - some collapse in large part. Some wood frame houses built especially to withstand earthquakes are thrown out of plumb, others are shifted wholly off foundations. Reservoirs are seriously damaged and underground pipes sometimes break.

X **Panic is general.**

Ground, especially when loose and wet, cracks up to widths of several inches; fissures up to a yard in width run parallel to canal and stream banks. Landsliding is considerable from river banks and steep coasts. Sand and mud shifts horizontally on beaches and flat land. Water level changes in wells. Water is thrown on banks of canals, lakes, rivers, etc. Dams, dikes, embankments are seriously damaged. Well-built wooden structures and bridges are severely damaged, and some collapse. Dangerous cracks develop in excellent brick walls. Most masonry and frame structures, and their foundations, are destroyed. Railroad rails bend slightly. Pipe lines buried in earth tear apart or are crushed endwise. Open cracks and broad wavy folds open in cement pavements and asphalt road surfaces.

XII **Panic is general.**

Disturbances in ground are many and widespread, varying with the ground material. Broad fissures, earth slumps, and land slips develop in soft, wet ground. Water charged with sand and mud is ejected in large amounts. Sea waves of significant magnitude may develop. Damage is severe to wood frame structures, especially near shock centers, great to dams, dikes and embarkments, even at long distances. Few if any masonry structures remain standing. Supporting piers or pillars of large, well-built bridges are wrecked. Wooden bridges that "give" are less affected. Railroad rails bend greatly and some thrust endwise. Pipe lines buried in earth are put completely out of service.

XII **Panic is general.**

Damage is total, and practically all works of construction are damaged greatly or destroyed. Disturbances in the ground are great and varied, and numerous shearing cracks develop. Landslides, rock falls, and slumps in river banks are numerous and extensive. Large rock masses are wrenched loose and torn off. Fault slips develop in firm rock, and horizontal and vertical offset displacements are notable. Water channels, both surface and underground, are disturbed and modified greatly. Lakes are dammed, new waterfalls are produced, rivers are deflected, etc. Surface waves are seen on ground surfaces. Lines of sight and level are distorted. Objects are thrown upward into the air.

Table 3 (Earthquakes within 100 km of Los Altos are underlined.)
Prominent earthquakes in California, 1769 through September 1971

(Intensity VIII and above)

	Date	Region	Richter Magnitude	Modified Mercalli Intensity
28	Jul 1769	Los Angeles region	*	
8	Dec 1812	Southern California		VIII-IX
21	Dec	Off coast of southern California		X
10	Jun 1836	San Francisco Bay		IX-X
	Jun 1838	San Francisco region		X
10 or 11	Jul 1855	Los Angeles County		VIII
9	Jan 1857	Near Fort Tejon	Possibly 8	X-XI
26	Nov 1858	San Jose		VIII
12	Nov 1860	Humboldt Bay		VIII
3	Jul 1861	Near Livermore		VIII
1	Oct 1865	Fort Humboldt-Eureka area		VIII-IX
8	Oct	Santa Cruz Mountains		VIII-IX
21	Oct 1868	Hayward		IX-X
26	Mar 1872	Near Lone Pine	Possibly 8	X-XI
19	Apr 1892	Vacaville		IX
21	Apr	Winters		IX
4	Apr 1893	Northwest of Los Angeles		VIII-IX
20	Jun 1897	Near Hollister		VIII
14	Apr 1898	Mendocino area		VIII-IX
22	Jul 1899	San Bernardino County		VIII
25	Dec	San Jacinto-Hemet area		IX
27 & 31	Jul 1902	Santa Barbara County		VIII
18	Apr 1906	San Francisco region	8.3	XI
18	Apr	Brawley, Imperial Valley	6 to 6.9	VIII
28	Oct 1909	Humboldt County	6+	VIII
11	Jan 1915	Los Alamos		VIII
22	Jun	El Centro-Calexico-Mexicali area	6.25	VIII
21	Apr 1918	San Jacinto-Hemet area	6.8	IX
21	Jun 1920	Inglewood		VIII
10	Mar 1922	Cholame Valley	6.5	IX
29	Jun 1925	Santa Barbara area	6.3	VIII-IX
22	Oct 1926	Monterey Bay	6 to 6.9	VIII
20	Aug 1927	Humboldt Bay		VIII
4	Nov	West of Point Arguello	7.5	IX-X
25	Feb 1930	Westmorland	5.0	VIII
1	Mar	Brawley	4.5	VIII
6	Jun 1932	Humboldt County	6.4	VIII
10	Mar 1933	Near Long Beach	6.3	IX
7	Jun 1934	Parkfield	6.0	VIII
18	May 1940	Imperial Valley	7.1	X
30	Jun 1941	Santa Barbara-Carpinteria area	5.9	VIII
15	Mar 1946	North of Walker Pass	6.25	VIII
29	Jul 1950	Imperial Valley	5.5	VIII
21	Jul 1952	Kern County	7.7	XI
22	Aug	Bakersfield	5.8	VIII
25	Apr 1954	East of Watsonville	5.25	VIII
21	Dec	Eureka	6.6	VII
8	Apr 1968	Northeast San Diego County	6.5	VII
1	Oct 1969	Santa Rosa	5.7	VII-VIII
9	Feb 1971	San Fernando	6.6	VIII-XI

* The Richter magnitude scale was not devised until 1931. If values appear in this column for earthquakes which occurred prior to that date, the magnitudes were determined as follows: 1) if given to the nearest tenth, the records of older instruments were correlated with records of instruments now in use; 2) otherwise, historical records of intensity were used to estimate magnitude.

from California Geology, November 1971

IV. EFFECTS OF SEISMIC AND GEOLOGIC HAZARDS ON THE EXISTING ENVIRONMENT OF LOS ALTOS

A. Earthquake Ground Shaking

With maximum shaking no greater than that associated with the 1906 earthquake on the San Andreas fault (M 8.3 on the Richter Magnitude Scale), we can estimate the probable effects of a future great earthquake in Los Altos. It must be kept in mind that the intensity experienced in Los Altos as a result of movement along the San Andreas or another fault system could possibly be greater than anticipated. The City's structural environment is described below, along with anticipated damage associated with ground shaking of Intensity VIII-IX (Modified Mercalli).

1. Residential Buildings

The majority of residential structures in Los Altos are single-family dwellings built since incorporation in 1952. These homes are almost wholly of single- or two-story, wood-frame construction set on conventional shallow foundations. Many have masonry chimneys. Some have masonry facades. Some two- and three-story apartment and condominium buildings, mostly of wood-frame construction, are also present in the City. With the possible exception of some of the older apartment houses, the residential buildings should not experience severe structural damage from ground shaking during a moderate earthquake. Shattered windows, shattered stucco, cracked chimneys, and fallen roof tiles will be common and can be expected to cause injuries. Broken gas lines and overturned water heaters can trigger destructive fires. Procedures such as securing water heaters to a wall and/or the floor and insuring that ruptured gas lines are promptly shut off can decrease the fire hazard. During a great quake, some homes may be expected to get out of plumb or to leave their foundations. Residential buildings can also be severely damaged by landslides.

2. Commercial Buildings

Commercial development occurs in the Triangle Area and in five neighborhood centers scattered through the City. Construction types vary from simple wood-frame structures to larger buildings with steel truss-supported roofs. Unreinforced masonry buildings of average workmanship may suffer heavy damage, including partial collapse, during shaking of Intensity VIII-IX. Older buildings in the downtown commercial district should be examined to assess their susceptibility to collapse. Masonry facades, stucco walls, parapets, and heavy cornices will fall, presenting a hazard to people near affected buildings. Performance of newer steel reinforced structures will be variable depending on design, local ground conditions, and duration of shaking.

Buildings of the Civic Center are all of wood-frame construction and have been built to modern earthquake-resistant standards. Disaster plans call for setting up a portable 100-bed hospital in the Youth Center for emergency care. The hospital is stored near the Youth Center and can be quickly assembled at the planned location. The base for emergency operations will be at the Police Station, also in the Civic Center. As the Civic Center buildings are not expected to experience

severe damage due to ground shaking, it should be possible to carry out these emergency plans.

3. Schools and Hospitals

There are fifteen schools in the City which are currently being used for teaching purposes. They are all of wood-frame construction with stucco exteriors. All schools meet Field Act specifications. (The Field Act, passed by the California Legislature in 1933, sets mandatory seismic safety standards for all school construction.) The school buildings in Los Altos are not expected to be extensively damaged as a result of earthquake shaking, although intensities of VIII or IX (Modified Mercalli) may cause severe cracking and falling of stucco, shattered glass, shifting from foundations, and rupture of water pipes.

There are no general hospitals in Los Altos, but there are two major nursing home facilities, Pilgrim Haven and Beverly Manor. Pilgrim Haven includes both a modern two-story building and a group of older cottages. Beverly Manor is a relatively new, single-story building of wood-frame and stucco construction. These buildings should be relatively resistant to earthquake shaking.

In addition to those facilities, some single-family, wood-frame houses are used as nursing homes, each typically caring for three to five people.

El Camino Hospital, located in Mountain View near the intersection of Covington and Grant Roads, is the major medical facility serving the Los Altos area. Access to the hospital during an emergency is of great concern, and plans must be made to facilitate access to the hospital grounds.

4. Transportation Corridors

Two freeways are of major importance to Los Altos: Interstate 280 and California Route 85. Intersection of these routes and other arteries often involve a highway bridge or overpass. Such structures are generally designed to withstand a certain level of seismic shaking. But since past earthquakes (notably the San Fernando earthquake of 1971, M 6.6) have caused collapse of such overpasses, the possibility of failures in or near Los Altos during a moderate or major earthquake should be anticipated. The closure of Interstate 280 and/or Route 85 as a result of a major earthquake will throw considerable traffic onto Los Altos' major arterial streets. Designated evacuation routes should avoid overpass interchanges and take into account projected overload traffic patterns.

Freeway damage, however, will not isolate parts of Los Altos from one another because freeways run only along the south and east edges of the City. Moreover, Foothill Expressway has only one grade separation between Palo Alto and Interstate 280 and should remain passable between Loyola Corners and Palo Alto even after a major earthquake despite partial blocking by landslides. Los Altos arterials, such as San Antonio Road and El Monte Avenue and other streets are expected to remain passable although traffic may be impeded because of downed

poles and trees, sewer collapse, etc. The results of a possible rupture of the Hetch-Hetchy aqueduct which passes through the City near the intersection of Los Altos Avenue and El Camino Real should be investigated.

5. Water

Water is supplied to most of Los Altos residents by California Water Service Company. The northernmost area is served by the North Los Altos Water Company. California Water currently receives its supply from a large filtration plant located in Los Gatos via a main which follows the old railroad alignment from Los Gatos to Loyola Corners. This line crosses the potentially active Sargent-Berrocal fault zone and may be subject to rupture in the event of a major earthquake centered on that fault. The California Water Service Company also has 34 wells in Los Altos which are available for use when necessary. Although some of these might become contaminated because of sewer line failures, the remainder could provide emergency supplies if power is not interrupted or alternatively if Diesel-operated pumps are available for backup. California Water has emergency communications equipment that would enable them to proceed rapidly with repairs in the event of a power outage. The Company also has 15 million gallons of water stored in wood and steel tanks located in the foothills above the City. The likelihood of these tanks remaining intact, as well as the question of minor leakage and the time between regular inspections, needs to be investigated. Fifteen million gallons is only a half-day supply to customers at dry season peak loads, even assuming the delivery pipes were intact after a major quake. Fires occurring after a major quake could quickly deplete water supplies.

The North Los Altos Water Company serves about 350 homes and a few businesses. All water is pumped from wells within the service area and is stored in steel and wood tanks near the wells. Total storage is approximately 1.5 million gallons, about a one-day supply to customers at peak demand in the summer. Nearly half of this storage is at the company offices on Pleasant Way, where an emergency gasoline generator has been installed so that in the event of a power outage, water can be pumped from the storage tanks. Without heavy generating equipment, however, no water can be pumped from the wells themselves. Distribution lines are of the asbestos-concrete type, and some of these might well rupture during severe earthquake shaking. The North Los Altos Water Company has an emergency plan which calls for immediate shut-off of all water at the tanks in order to minimize water loss through broken pipelines. How any stored water is distributed after a disaster should be planned in cooperation with City officials to assure the best use of this vital resource.

In the event of water supply failures, emergency water for fire fighting might be obtained from existing wells, swimming pools (especially if located in advance), and neighboring water districts. Where fuel supplies for emergency equipment are stored in underground tanks, hand-operated pumps may need to be in readiness.

6. Power

Gas and electricity are supplied to the City by the Pacific Gas and Electric Company's Mountain View office. Throughout P.G.& E.'s

service area, electric transmission and distribution circuits are provided with various automatic control devices designed to return the system to as nearly normal operating conditions as possible after an interruption. Major transmission lines are located both in the baylands and in the foothills. Los Altos, therefore, receives power from multiple sources. After a major quake, outages of several days at least should be anticipated. Short supplies of power can be expected even after moderate shocks.

Natural gas for Los Altos residents comes from mains which parallel El Camino Real and Bayshore Freeway (U.S. 101). Gas pipelines within the City are all distribution lines, and some of these pipes can be expected to rupture as a result of a major quake. Residents should know how to shut off supply valves at their own homes to reduce the fire hazard in the event houselines are made unsafe or are ruptured.

7. Telephone

The Pacific Telephone and Telegraph Company provides telephone communication service to the City of Los Altos. Switching offices usually have emergency generating equipment that is tested periodically to ensure operation during a power outage. However, the complexity of the telephone network means that service is expected to be interrupted for at least 24 hours in the event of a major earthquake. Even if the equipment itself is not extensively damaged, the large number of calls immediately following a shock will result in an overload which will temporarily halt service. The City should have communication equipment ready and should not rely on telephone company repairs.

8. Sanitary Facilities

All wastes are ultimately delivered to the Palo Alto treatment plant, located at the edge of the Bay. However, strong ground shaking can be expected to cause rupture of some of the vitrified clay waste collection pipes within the City; and, as a result, untreated sewage may appear at the surface. Soils in Los Altos may be able to absorb some of the leakage. The severity of the health and sanitation problems will be directly related to the intensity of the earthquake and the area affected.

Individual septic tank drain fields are used only in a small area of the City bounded by Permanente Creek, Fremont Avenue, Grant Road, Altamead Drive, Buckingham Drive, and Portland Avenue. Soils in this part of the City have good drain field capabilities, and there has been no need for sewage installations. However, ground shaking may crack tile drains causing destruction of septic systems and the appearance of waste waters at the surface. The health hazard in the event of sanitary facility failure must be evaluated.

B. Fault Ground Rupture

Although no historically active faults are known to pass through the City, one cannot assume that earth movement within the Planning Area may not occur in the future. Although the status (active or inactive) of the Stanford fault is unknown, the possibility of rupture

along its trace is considered remote at the present time. If ground rupture on this fault were to occur, total offset would probably be measured in inches, and only structures in the northernmost section of the City would be affected. (See Plate 2, Geologic Map of Los Altos.)

Traces of the Sargent-Berrocal fault are near enough to the City's southern boundaries that movement along them could cause ground failures within Los Altos. Earthquake-induced landsliding could be of particular concern.

C. Landsliding, Slumping, and Mudflows

Although earth movements have not yet become a serious hazard in Los Altos, areas of steeper slopes and unstable ground will eventually be incorporated into the City. The Santa Clara Formation, which underlies most of the area between Foothill Expressway and Interstate 280, has a history of instability because of its clayey-gravel composition and poor consolidation. Landsliding in this area would primarily affect residential structures, but roads and utilities could also be involved. Interstate 280 has a history of slumping and sliding, some of which is due to unstable cuts into the Santa Clara Formation.

Both major water lines and a 220 Kv electric transmission line traverse the foothill area southwest of the City. Landslides triggered by earthquake shaking could damage the lines and result in partial loss of power and water to Los Altos. Water tanks located in the foothills are also subject to possible landslide damage. Stability of the earth associated with the tanks and with power and water lines should be evaluated.

D. Soil Liquefaction

Soil liquefaction requires the combination of strong ground shaking with susceptible soils under water-saturated conditions. Both the older alluvial fan unit and the Santa Clara Formation have a low liquefaction potential because of deep water tables and soils that are poorly sorted and relatively firm. The younger alluvial fan deposits, however, are associated with a somewhat higher water table, and may have a locally high liquefaction potential, particularly near Stevens Creek.

Liquefaction potential is high only if susceptible soils are saturated, a condition generally restricted to the winter months. Since most liquefaction-prone soils are near the surface, water must be within about 10 feet of ground level to produce a potentially hazardous condition. Within the Younger Alluvial Fan Unit, water tables reach this level infrequently, and only in certain areas. The hazard is greatest near existing watercourses, where liquefaction could cause lateral spreading landslides into the creeks. Soils reports for creekside developments and public buildings (schools, hospitals, etc.) should be examined, with liquefaction potential in mind. Structures throughout the City are one- or two-story wood frame, and, with the exception of creekside homes, should not experience significant damage due to liquefaction. If severe shaking were to

occur during a very wet winter, some creekside homes might be damaged due to slumping or lateral spreading.

E. Settlement and Subsidence

No settlement hazard is thought to exist presently in the Los Altos area. Former subsidence of up to 3 feet recorded for parts of north Los Altos was caused by a now discontinued water withdrawal program.

F. Lurching

The number of natural channel creeks in Los Altos makes the likelihood of lurching during an earthquake relatively high. Because the large cracks associated with lurching of creek banks are most commonly found close to the stream, existing structures which are too close to stream banks may experience foundation cracking or undercutting. The best precaution against this type of damage for new structures is a setback requirement.

At the present time, all proposals for development within 50 feet of a creek bank are referred to Santa Clara Valley Water District for review. Since proposals are reviewed by the District at the tentative map stage, setbacks from the creek can be specified where necessary. In general, the District requires that all structures adjoining natural creeks be set back by the greater of the following two distances: (1) Twenty-three feet from the top of the bank; or (2) Twenty-three feet from the top of a 2:1 (horizontal to vertical) slope projected upward from the bottom of the bank. For areas of high velocity flow, an extra 10 feet may be required. For lined channels, the minimum setback is equal to the channel depth.

These setbacks represent a relatively conservative approach for seismic safety purposes. Some types of ground failure which are difficult to predict in advance could extend back far enough to involve creekside homes. However, it would be impractical to plan for such failures by means of a standard setback, and it is felt that current practices are reasonable.

G. Earthquake Related Flooding

An inundation map for Stevens Creek Reservoir has been prepared by Santa Clara Valley Water District engineers, and is in the process of being approved by the State. This map shows the extent of potential flooding if Stevens Creek Dam were to fail. The map shows flood waters moving out to the northeast of Stevens Creek rather than to the west, and no part of the Los Altos Planning Area is included within the inundation area. However, Los Altos should determine the effect on the City (and on El Camino Hospital) of the inundation of large areas of neighboring communities.

Other potential sources of flooding during an earthquake are pipelines and water tanks. Rupture of the water main from Los Gatos could flood some areas before broken sections were recognized and valved off. Water tanks in the area are mostly at or below grade, and do not present a major hazard, although local flooding could occur due

to cracking or failure of individual structures. The Hetch-Hetchy aqueduct could be a source of localized flooding where it crosses the City limits.

H. Tsunamis and Seiches

Los Altos is too far from the ocean or the Bay to be affected by tsunamis.

Seiche hazards are also unknown, as no bodies of water large enough to generate a damaging seiche are known to exist within or near the City. Seiches in Stevens Creek Reservoir could overtop the dam, but Los Altos would not lie in the path of these waters.

V. RECOMMENDED SEISMIC SAFETY POLICIES

The recommendations of this element are based on the most reliable and current information available. However, the fields of seismology, engineering geology, and earthquake engineering are relatively new disciplines where major efforts are now being made and from which vital new information is continually coming forth. Therefore, whatever course the City chooses to follow must provide for periodic review and updating of programs to keep them abreast of new developments. The following policies are recommended to best protect the public health, safety, and welfare in the event of a major earthquake.

a. Actively cooperate with the seismic safety programs of other jurisdictions, regional districts, and neighboring cities.

b. Rejecting a fatalistic attitude, institute additional local programs as required to mitigate hazards and prepare for a disaster.

c. Provide continuing City-wide educational programs.

d. Evaluate the adequacy of utility and service company plans and verify that their seismic safety programs have been put into effect.

e. Resisting an overly parochial approach, assess readily imaginable events that could occur outside the Planning Area that would decisively affect it.

f. Employing the concept of "acceptable risk", adopt Building and Municipal Code additions and modifications that promote a safer environment with regard to earthquake hazards.

g. Provide a means for periodic updating and review of the City's programs.

VI. RECOMMENDED CITY ACTION PROGRAM

Each of the following recommendations is followed by a discussion designed to help decisionmakers evaluate its benefits and costs. Because the time of the next damaging earthquake is unknown and the consequences of inaction are serious, it is recommended that implementation of this action program commence at once. Except where a continuing process is specified or implied, implementation should be completed within one year.

A. Recommendation

The City Council should establish a Seismic Safety Committee made up of representatives of the Council, the Planning Commission, the City staff (including members of the Fire, Police, Planning, and Public Works Departments), and advisory members from the community who can contribute expertise in relevant fields such as geology, radio communications, emergency medical services, etc. The Seismic Safety Committee would be responsible for carrying out an educational program, including the preparation and distribution of an earthquake newsletter providing citizens with information about actions they can take before, during, and after a major earthquake to reduce the severity of the disaster. The Committee would also keep abreast of developments in earthquake research and disaster preparedness planning at the federal, state, regional, and county levels.

Discussion

The establishment of the Seismic Safety Committee would greatly facilitate the efforts of the City to prepare the community for an earthquake. With knowledgeable and interested citizens to aid the City staff in the preparation and dissemination of educational materials, the planning and carrying out of earthquake drills, the monitoring of the plans of other jurisdictions, etc., the monetary costs would be far below those incurred were the City to rely solely on staff time and that of paid consultants. The involvement of community members provides a means of exciting greater and more widespread awareness of and interest in the City's programs and should elicit useful suggestions.

B. Recommendation

The City should survey all masonry buildings constructed prior to the City's adoption of the Uniform Building Code to determine if any of these buildings would present an undue hazard to life and property during strong earthquake shaking. If any such structures are located, they should be abated or brought up to current code standards.

Discussion

Most older masonry buildings are in the downtown area, although some older structures exist in other commercial centers. Since there are not very many of these buildings in Los Altos, and most of them are grouped together, the task of surveying them can be accomplished by staff personnel over a period of months, perhaps during the winter when less staff time is required for construction inspections.

Unreinforced masonry structures which are used by the public are a clear hazard to occupants during a strong earthquake. Such buildings can be either reinforced or abated through provisions of an unsafe building ordinance. If such an ordinance is found necessary, the City can adopt the Uniform Unsafe Building Code or one formulated to fit City needs.

C. Recommendation

The Building Department should see that owners correct potentially hazardous conditions in commercial areas, such as loose roof tiles, poorly tied parapets, cornices, signs, or other objects that may fall during seismic shaking.

Discussion

Falling objects are the major cause of injuries during an earthquake. A cursory examination suggests that some Los Altos buildings might have conditions such as those mentioned above.

Implementation of this recommendation would not require funding and could probably be accomplished without large amounts of staff time, perhaps in conjunction with the survey of older masonry buildings. Alternatively, the Building Department could conduct an annual survey of structures in commercial areas that have external features that could become loose. Cornices, parapets, and facades on new buildings should be inspected to ensure that they are properly tied to the structure.

D. Recommendation

The City should take further steps to define adequately its geologically hazardous areas. In addition, a geologic data file should be established in the Planning Department for the collection of all maps, reports, and other pertinent data, the file to be augmented as new material becomes available. A reference to the data file should be a required part of the regular approvals procedures.

Discussion

Definition of the hazardous areas might take the form of an interpretive map annotated by an earthquake engineer. Because Los Altos is largely developed, the cost of preparation of such a map would not be excessive. The collection of data for the file and requiring reference to it would not require significant expenditures of monies or of additional staff time. The City should request from the Santa Clara County Geologist copies of all soils and geologic reports submitted for structures to be built outside the current City limits but within the Los Altos Planning Area. Relevant federal, state, or private geologic studies should be added to the file as they become available.

E. Recommendation

Chapter 3, Section 10-3.30 of the Los Altos Municipal Code should be changed to read as follows (additions underlined, deletions lined out):

Sec. 10-3.30. Required soil and geologic reports.

Each subdivider shall provide ~~a~~ preliminary soil and geologic reports, ~~prepared by a civil engineer who is registered by the State~~, based upon adequate test borings or excavations of every subdivision, and prepared by civil engineers and engineering geologists registered in the State of California ~~as defined in Sections 11535 and 11535.1 of the Business and Professions Code of the State~~.

Either or both of the preliminary soil and geologic reports may be waived if the City Engineer shall determine that, due to the knowledge his department has as to soil and geologic conditions ~~qualities of the soil~~ of the subdivision or lot, no preliminary analysis is necessary.

Discussion

This recommendation is intended to ensure the early recognition of potential soils and geologic problems that could make the proposed development unfeasible. The addition of geologic reports to Section 10-3.30 is important in the recognition of unstable geologic conditions such as large landslides, rock units which are especially susceptible to landsliding, or rocks oriented in such a way as to favor slope failure. These conditions are generally not assessed as part of a soil report and may, therefore, be neglected.

No funding will be necessary for implementation of this recommendation.

F. Recommendation

Chapter 3, Section 10-3.06 (c) of the Los Altos Municipal Code should be amended to read as follows (additions underlined):

(c) Upon receipt of the map from the City Planner, the City Engineer shall investigate the lot sizes, the sewage disposal system, the drainage system, and the domestic water supply system for the proposed subdivision and shall submit his recommendation to the City Planner. The City Engineer shall also note in his report the presence of any naturally hazardous conditions, such as unstable ground or susceptibility to flooding, which could make the site unsuited for the proposed development.

Discussion

This addition to paragraph (c) will ensure that conditions known to be hazardous are recognized at the tentative map stage, rather than later in the planning process, when it may be too late or too expensive to make necessary changes in project design. No funding is necessary for implementation of this recommendation.

G. Recommendation

The City needs a formal review process for geologic and soils reports to ensure that hazardous development is avoided. Review should be by a licensed geologist, with certification in engineering geology.

Discussion

This recommendation is very important if hazardous land use is to be avoided, because unless soils and geologic reports are reviewed by a qualified professional, omissions or inaccuracies in these reports may go unnoticed. Adequate review may be obtained by arrangements with the County Geologist or by contract with private consultants, but will probably require funding or arrangements for reimbursement from applicants. Since the number of reports involved at this time is small, the hiring of additional full-time staff will not be necessary. A number of nearby cities have successful programs of this type, and their experience would provide a useful basis for implementing such a program.

H. Recommendation

Required soil and foundation engineering investigations should include evaluation of liquefaction potential for all structures other than one- or two-story, wood-frame dwellings, when such structures are to be located within the Younger Alluvial Fan Unit.

Discussion

The recognition of liquefiable soils is critical in the location of large or high-occupancy structures. Once their existence is known, appropriate design modifications can ensure the safety of these structures. Implementation of this recommendation should not require special funding or staff time, but will provide increased safety for Los Altos residents in the event of a major earthquake.

I. Recommendation

The City should adopt the most recent edition of the Uniform Building Code, including Chapter 70. City staff should assure that soil and geological reporting procedures are adhered to in all hillside developments.

Discussion

By adopting the most recent edition of the Uniform Building Code the City insures that new construction will meet current standards. The adoption of Chapter 70 is particularly important, since Los Altos currently has no hillside grading ordinance. Implementation of this recommendation might actually result in some monetary savings if hazardous conditions can be avoided in hillside developments.

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